Halacarid mites (Acari: Halacaridae) in a freshwater influenced beach of North Stradbroke Island, Moreton Bay, Queensland

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ABSTRACT

Six species of halacarid mites were found in a sandy slope and an adjacent mud flat, both strongly influenced by freshwater. *Acarochelopodia biunguis* Bartsch, 1988, *Copidognathus psammobius* sp. nov. and *Halacaroides australiensis* sp. nov. are exclusively arenicolous, obviously tolerating freshwater saturation. *Copidognathus cooki* Bartsch, 2003, inhabits the mud flat; previous records are from brackish rivers and creeks. *Limnohalacarus billabongis* Bartsch, 1999, and *Lobohalacarus weberi* Romijn & Viets, 1924, are typically freshwater inhabitants. All species are diagnosed and the new species are described. ❑ *Australia, Halacaridae, marine littoral, brackish water, new species, description.*

The Halacaridae includes more than 1000 marine and about 50 freshwater species (Bartsch 1996, 2004). Several species belonging to marine genera can survive in brackish or even fresh water, while typically freshwater species are also regularly found in brackish water habitats. One of the beaches examined, with a small sandy slope and an adjacent mud flat, proved to be strongly influenced by freshwater, and samples from that beach contained a range of taxa that are normally variously classified as limnic, marine, or brackish. The interstitial fauna of the sediment from just above the freshwater table of the sandy slope contained, amongst others, the three species *Acarochelopodia biunguis* Bartsch, 1988, *Copidognathus psammobius* sp. nov. and *Halacaroides australiensis* sp. nov. The sediment at the lower edge of the slope and the adjacent flat was inhabited by the halacarid mites *Copidognathus psammobius, Copidognathus cooki* Bartsch, 2003, *Limnohalacarus billabongis* Bartsch, 1999 and *Lobohalacarus weberi* (Romijn & Viets 1924). The two latter genera are listed as freshwater, whereas *Acarochelopodia, Copidognathus* and *Halacaroides* are normally considered marine.

COLLECTION SITE

North Stradbroke Island is rich in a system of freshwater swamps and lakes paralleling the shore and freshwater often seeps into the adjacent Moreton Bay mudflats. Adam's Beach, south of the Dunwich ferry terminal, has such a seepage area. From the Moreton Bay landward there is a tidal muddy flat, with mangrove stands (*Avicennia*, Avicenniacea), small patches with *Juncus* (Juncaceae) and *Triglochin* (Juncaginaceae), a sandy beach slope, a small dune and behind that a freshwater swamp. The upper sediment layers in the tidal slope consisted of a medium coarse clean quartzite; in 10–30 cm depth, this sediment was replaced by a layer that included large amounts of phytal debris; the interstitial water became fresh. Freshwater was seeping into the flat along the lower edge of the slope, and during low tide, the salinity in the muddy surface layer was reduced to 2–3‰. A small subsurface freshwater creek, several centimetres in width and depth, extended for a few meters into the flat, easily recognisable because the sediment consisted of fine, oxygenated sand, in contrast to the adjacent flat with dense mud that turned anoxic

black immediately below the surface. The salinity in the subsurface sediment, in 3–5 cm depth, was 2–3‰ during low tide. During the high tide period, the flat and slope were covered by water of 30‰ and more.

MATERIALS AND METHODS

From the upper, middle and lower sandy slope, several sediment samples, 200–400 ccm each, were collected from just beneath the sediment surface to the groundwater horizon. From the lower edge of the slope and the tidal flat, amongst the *Triglochin* and *Juncus* stands, the surface layer of debris, less than 1 cm thick, was collected (sample volume less than 100 ccm). To get sediment from the subsurface freshwater creek a collecting jar, pressed into the sediment, was unlocked once it reached the subsurface position. All the samples were taken to the laboratory. The sediment samples were repeatedly stirred in water and the water decanted through a 100 μm net. Samples with debris were washed with a jet of water. The halacarids were extracted, using 12–25 x magnification, and preserved in ethanol. The mites were cleared in lactic acid and mounted in glycerine jelly. Holotypes and a number of paratypes and voucher specimens are deposited in the Queensland Museum, Brisbane (QM), other slides in the Senckenberg Museum, Frankfurt (SMF) and Zoological Institute and Zoological Museum, Hamburg (ZMH). Some voucher specimens have been retained in the author's collection (IBC).

Abbreviations used in the descriptions: AD, anterior dorsal plate; AE, anterior epimeral plate; ds-1 to ds-5, first to fifth (pair of) dorsal idiosomal seta(e), numbered from anterior to posterior; GA, genitoanal plate; GO, genital opening; GP, genital plate; OC, ocular plate(s); P-2 to P-4, second to fourth palpal segment; pas, parambulacral seta(e); PD, posterior dorsal plate; PE, posterior epimeral plate(s); pgs, perigenital setae, numbered pgs-1, pgs-2, etc, from anterior to posterior. The legs are numbered I to IV. The position of a gland pore is given in a decimal system, with reference to the length of a plate, from its anterior to posterior margin. The diagnoses of the species are prepared on the basis of the Moreton Bay specimens.

RESULTS

The interstitial fauna of the sandy slope, just above the water table, was dominated by *Hexabathynella* sp. (Syncarida, Bathynellacea) and the three halacarid mite species *Acarochelopodia biunguis*, *Copidognathus psammobius* and *Halacaroides australiensis*. Other meiofaunal taxa were sparse, restricted to turbellarians, enchytraeids (Oligochaeta) and a few nematodes, harpacticoids and ostracods. The surface sediment of the bare flat and amongst the *Triglochin* stands held a rich meiofauna with tubellarians, nematodes, oligochaetes, harpacticoids, ostracods, and larvae of insects; the mite fauna was dominated by a species of the otherwise limnic oribatid genus *Trimaloconothrus* sp. (Acari: Malaconothridae), halacarids were represented by *Copidognathus psammobius* and *C. cooki*. The oxygenated sand of the subsurface creek held a rich mite fauna; most abundant was the oribatid *Trimaloconothrus* sp., followed by the halacarids *Limnohalacarus billabongis* and *Lobohalacarus weberi*. Other taxa such as turbellarians, nematodes, oligochaetes and the larvae of insects, were rare, harpacticoids and ostracods lacking.

SYSTEMATICS

The genera are arranged in an alphabetical order, the diagnoses of the marine (*Acarochelopodia*, *Copidognathus*, *Halacaroides*) and freshwater genera (*Limnohalacarus*, *Lobohalacarus*) follow Bartsch (2006a, b).

Acarochelopodia Angelier, 1954

Type species: *Acarochelopodia delamarei* Angelier, 1954.

Acarochelopodia biunguis Bartsch, 1988 (Fig. 1A, B)

Acarochelopodia biunguis Bartsch, 1988: 217–218, figs 10–16; Otto, 2000: 125–126, figs 8a–i.

Material Examined. QM-S83656, ♂, Adam's Beach, Dunwich, North Stradbroke I., Moreton Bay (c. 27°30'S, 153°24'E), upper slope, ground water table, 18.02.2005, I. Bartsch. IBC, ♂, deutonymph, data as above.

Diagnosis. Length of male 164–190 μm. All plates delicate, almost smooth. AD and PD subquadrangular. Pair of ds-1 on AD slightly posterior to level of gland pores. Pair of ds-5 on PD somewhat posterior to anterior margin of PD. Epimera I and II of either side fused, in the median divided; each plate posteriorly drawn out into

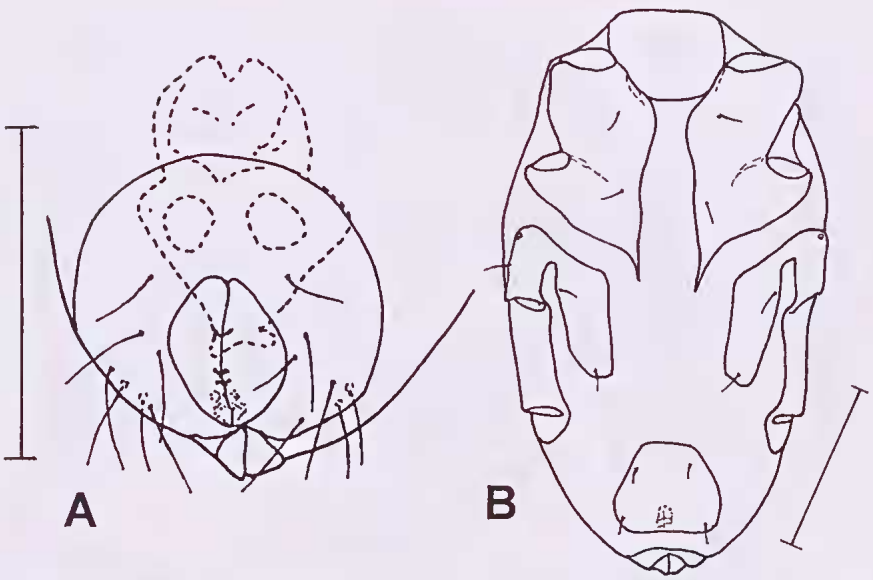

FIG. 1. *Acarochelopodia biunguis* Bartsch, 1988; A, Genitoanal plate, ♂; B, idiosoma, ventral, deutonymph. Scale line = 50 μm (A, QM-S83656; B, IBC).

narrow tail-like extension. Each of PE with longitudinal wedge, incompletely separating marginal from ventral portion; PE with gland pore, one dorsal seta and two ventral setae. Gnathosoma short, distal seta on P-2 much longer and wider than preceding seta. Leg chaetotaxy (pas excluded, solenidion included, large strongly denticulate spines in roman numerals): 1, 2, 3+I, 3+II, 3+VI, 7; leg II, 1, 2, 3, 4, 5, 5; leg III, 1, 1, 2, 3, 5, 4; leg IV, 1, 1, 2, 3, 5, 3. Spine of telofemur I short, in ventral position. Ventromedial spine of genu I short, ventrolateral one long. Tibia I with two and four long ventromedial and -lateral spines, respectively. Tarsus I slender, with one dorsal seta near base and two setae in about middle of segment. Tarsi II to IV with paired claws; central sclerite with minute tooth.

Supplementary Description. *Male.* GA with seven pairs of pgs (Fig. 1A). Genital sclerites with three pairs of short sgs. Internal genital acetabula in posterior GO. Spermatopositor extending beyond anterior margin of GA.

Deutonymph. Length of idiosoma 165 μm. Dorsal aspect similar to that of adults. Pair of AE posteriorly with tail-like, pointed extensions (Fig. 1B). PE incompletely divided and, as in adults, with gland pore, one dorsal seta and two ventral setae. GP quadrangular; with two pairs of pgs and two pairs of internal acetabula.

Distribution & Biology. First recorded from Hawaii (Bartsch 1988), with a second record from Queensland, from just north of Cairns (Otto 2000). All records are from tidal beaches. The recent record from North Stradbroke I. is the only one from almost freshwater. The species is expected to be spread in the tropical and warm-temperate Pacific Ocean.

Copidognathus Trouessart, 1888

Type species: *Copidognathus glyptodernus* Trouessart, 1888.

Copidognathus psammobius sp. nov.

(Figs 2A–F, 3A–H)

Material Examined. HOLOTYPE: QM-S83657, ♂, Adam's Beach, Dunwich, North Stradbroke I., Moreton Bay (c. 27°30'S, 153°24'E), flat immediately at the edge of the slope with *Triglochin*, surface sediment (0–2 cm depth), 17.02.2005, I. Bartsch. PARATYPES: QM-S83658, ♀, collection data as above. QM-S83659, ♀, collection data as above. SMF, ♂, collection data as above. ZMH, ♂, collection data as above. OTHER MATERIAL. SMF, ♀, Adam's Beach, Dunwich, North Stradbroke Is., Moreton Bay (c: 27°30'S, 153°24'E), flat immediately at the edge of the slope with *Triglochin*, 3–5 cm sediment depth, 17.02.2005, I. Bartsch. QM-S83660, ♂, Adam's Beach, Dunwich, North Stradbroke I., Moreton Bay, sediment from middle beach slope, about 20 cm sediment depth, 18.02.2005, I. Bartsch. ZMH, ♀, ♂, collection data as above. IBC, 2 ♀♀,

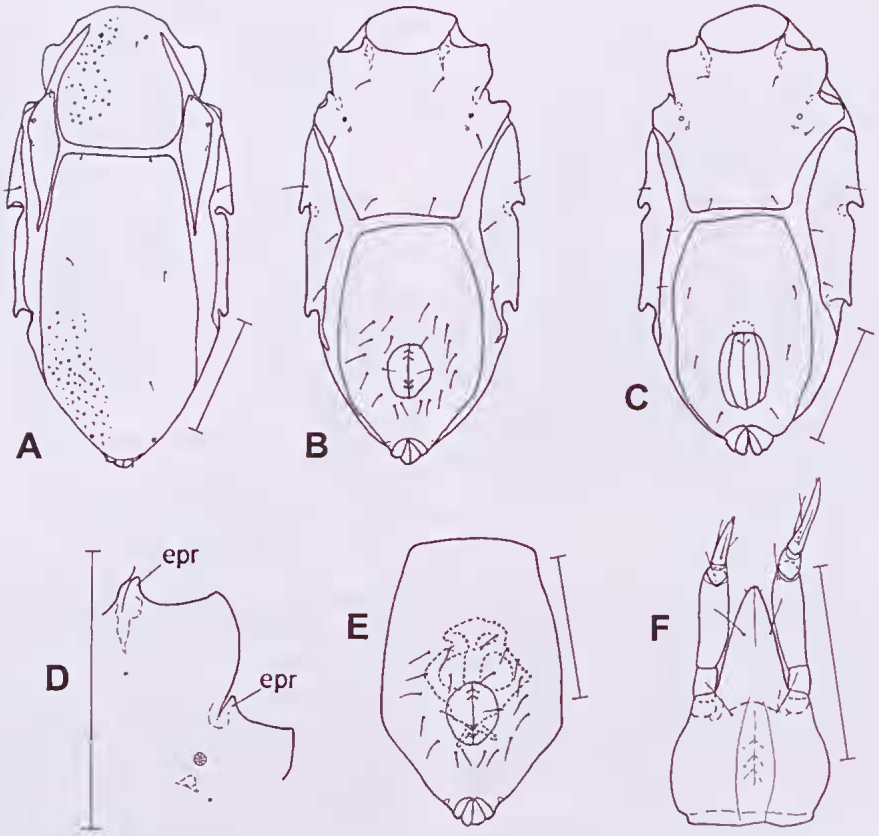

FIG. 2. *Copidognathus psammobius* sp. nov.; **A**, Idiosoma, dorsal, ♂; **B**, idiosoma, ventral, ♂; **C**, idiosoma, ventral, ♀; **D**, left AE, ♂; **E**, genitoanal plate, ♂; **F**, gnathosoma, ventral, ♂. Scale line = 50 μm (epr = epimeral process) (A, B, D, E, holotype QM-S83657; C, paratype QM-S83658; F, paratype SMF).

North Stradbroke I., Moreton Bay, sandy slope near Polka Point (off the Moreton Bay Research Station), c. 27°30'S, 153°23'E, upper beach area, 20 cm sediment depth, 11.02.2005, I. Bartsch.

Diagnosis. Length of female 185–213 μm, of male 180–216 μm. Dorsal plates very delicately pitted, ventral plates finely punctate. Opposing margins of AD and PD and AE and GA truncate. OC narrow, extending beyond insertion of leg III. With pointed epimeral processes. Female GA with anterior pair of pgs close to margin of plate; ovipositor short. Male with 20–21 pgs. Rostrum not reaching to end of P-2. Tectum arched. Leg I wider and longer than leg II. Tarsus I with enlarged lateral fossa membrane. Leg chaetotaxy (solenidion included, pas and famulus excluded): leg I, 1, 2, 4, 3, 6–7, 7; leg II, 1, 2, 4, 3, 6–7, 4; leg III, 1, 2, 2, 2, 5, 4; leg IV, 0, 2, 2, 3, 5, 3. Tibiae I to IV with 2, 2, 1, 1 bipectinate setae. Claws of tarsi II to IV with few large tines.

Description. *Male.* Length of idiosoma 180–216 μm, length of holotype 192 μm, width 94 μm. Dorsal plates evenly punctate and with scattered pits (Fig. 2A), each pit 1–2 μm in diameter; otherwise without marked ridges and ornamentation. With three small spots of black eye pigment, one beneath AD and one beneath each of OC. Anterior margin of AD arched, posterior margin truncate; length of plate 57 μm, width 51 μm. Gland pores at 0.2. OC slender, elongate; their length 58 μm, width 16 μm, posteriorly pointed and extending beyond insertion of leg III. Gland pore and adjacent pore canaliculus in lateral margin. Cornea absent. Length of PD 128 μm, width 67 μm; anterior margin truncate. Gland pores at 0.9. Dorsal idiosomatic setae slender, short. Pair of ds-1 on AD slightly posterior to

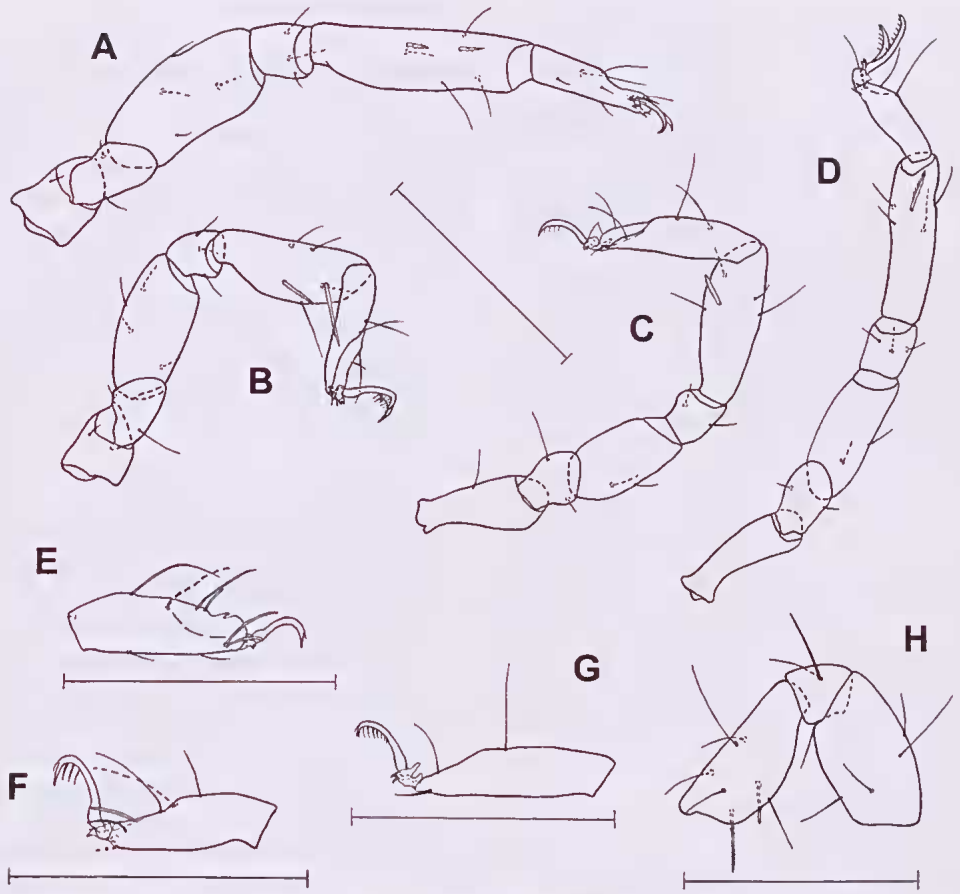

FIG. 3. *Copidognathus psammobius* sp. nov.; **A**, Leg I, ventromedial, ♂; **B**, leg II, medial, ♂; **C**, leg III, medial, ♂; **D**, leg IV, ventromedial, ♂; **E**, tarsus I, lateral, ♀ (medial fossary seta in broken line, medial parambulacral setae and claw omitted); **F**, tarsus II, lateral, ♂ (medial fossary seta and parambulacral seta in broken line); **G**, tarsus IV, lateral, ♀ (medial fossary seta, parambulacral seta and claw omitted), **H**, telofemur to tibia II, lateral, ♂. Scale line = 50 μm (A–D, holotype QM-S83657; E, G, paratype QM-S83659; F, H, QM-S83660).

gland pores; ds-2 in anteromedial corner of OC; ds-3 to ds-5 on PD as illustrated; adanal setae on anal cone.

Surface of ventral plates delicately punctate. Length of AE 66 μm, width 83 μm; epimeral processes I and II lamelliform (Fig. 2B, D). Pair of epimeral pores small, four marginal tines constricting the opening (Fig. 2D). Plate with three pairs of setae. Posterior margin of AE truncate. PE with one dorsal and three ventral setae; length 93 μm; PE extending beyond insertion of leg IV. Anterior margin of GA truncate; length of plate 101 μm, width 64 μm. Length of GO 22 μm, width 17 μm. Interval between GO and anterior margin of GA 2.1 times length of GO. With 10–11 pgs on either side of GO. Spermatopositor extending slightly beyond anterior pgs (Fig. 2E).

Length of gnathosoma 56 μm, width 39 μm, with two pairs of maxillary setae. Rostrum in ventral aspect triangular (Fig. 2F), not extending to end of P-2, somewhat shorter than gnathosomal base. Rostral sulcus extending just beyond apical pair of maxillary setae. Tectum arched. P-2 with one dorsal seta; no seta on P-3; P-4 with three setae in basal whorl, setula and two spurs at its tip.

Leg I longer than leg II (Fig. 3A and B). Tibiae I and II slightly longer than the legs telofemora,

tibiae III and IV distinctly longer than telofemora (Fig. 3C and D). Telofemora I and II 1.7 times longer than high; telofemora III and IV almost twice as long as high. Leg chaetotaxy (holotype, solenidion included, pas and famulus excluded): leg I, 1, 2, 4, 3, 6, 7; leg II, 1, 2, 4, 3, 6, 4; leg III, 1, 2, 2, 2, 5, 4; leg IV, 0, 2, 2, 3, 5, 3. Tibia I ventrally with two short, delicately bipectinate setae and one smooth and slender seta. Apical one of the two bipectinate setae on tibia II distinctly longer than basal seta. Tibiae III and IV each with one short, bipectinate and one smooth, slender seta. Apex of tarsus I with large lateral membrane; medial membrane as well as fossa membranes of the other legs inconspicuous. On tarsus I one of the two distal fossary setae inserted at base of claw fossa, the other on lateral membrane (Fig. 3E); solenidion immediately adjacent, 5 μm long. Venter of tarsus I with three setae and apical pair of doubled pas. Solenidion on tarsus II 10 μm long, in dorsolateral position and close to parambulacral seta (Fig. 3F); tarsus II with pair of pas singlets. Tarsi III and IV with four and three dorsal setae, respectively, two distal setae paired, inserted close to tip of tarsi; apex with pair of pas (Fig. 3G).

Claws slender, on tarsus I shorter than on following tarsi. Claws with accessory process, on tarsi II to IV with few long and slender tines. Median claw bidentate.

Female. Length of idiosoma 185–213 μm. Dorsal aspect same as that of male. GA longer than AE, anterior margin truncate (Fig. 2C). Setae pgs-1 and pgs-2 close to lateral margins, pgs-1 somewhat anterior to the level of insertion of leg IV. GO in posterior portion of GA, distance to anterior margin of GA equalling 1.5 times length of GO. Ovipositor only sligthly passing beyond margin of GO.

Variations. On tibiae I and II both three and four dorsal setae were found. In one male the tibiae of one side had three on the other side four dorsal setae (Fig. 3H). Twelve of the tibiae I examined had 3/3 dorsal/ventral setae, six tibiae the combination 4/3, and in one female, one of the tibiae I had unilaterally 3/2 dorsal/ventral setae, one of the bipectinate ventral setae was lacking, the other tibia had 3/3 setae. On tibia II the combinations 3/3 and 4/3 dorsal/ventral setae were found nine and five times, respectively.

Remarks. Species similar to *C. psammobius* are *C. mirus* Bartsch, 1984, *C. consobrinus* Bartsch, 1991, *C. cribellus* Bartsch, 1993, *C. laeviusculus* Bartsch, 1993, *C. lepidus* Bartsch, 1977, and *C. majorinus* Bartsch, 1993. They are all known from the Indo-Pacific area (Bartsch 1977, 1984, 1991, 1993), and are small, the idiosoma less than 240 μm, the surface of the dorsal plates lacks costae or clearly delimited porose areolae, and any ornamentation, if present, is either weak or rather uniform. The opposing margins of the AD and PD are truncate and the OC elongate and slender.

Copidognathus lepidus is recorded from the Galapagos Islands (Bartsch 1977). In contrast to *C. psammobius* and the other above mentioned species, the first pair of gland pores are inserted immediately adjacent to each other. Furthermore the tibiae bear large, pointed articular membranes, on the female GA the pgs are far from the lateral margin of the plate, and the ovipositor is large, extending far beyond the anterior margin of the GO. The length of the species is 199–204 μm.

Copidognathus consobrinus, from southern China (Bartsch 1991), has a length of 174–187 μm, its dorsal plates are uniformly punctate, not pitted, the OC are not conspicuously prolonged, in the males the perigenital setae are close to the GO, and tibia I has a cylindrical base that rapidly increases in height.

Copidognathus mirus is known from the Philippines (Bartsch 1984). The idiosomal length is 210 μm. Its dorsal plates are uniformly punctate, the OC are tail-like prolonged but shorter than in *C. psammobius*. In the single specimen of *C. mirus* studied the PE have no more than three setae, one dorsal, two ventral, the epimeral pores have a wide internal sacculus, opening on the AE with a slit, and the pair of genital acetabula are enlarged and sacculiform. The function of the enlarged epimeral pores and genital acetabula is not known and consequently it cannot be excluded that these structures are enlarged only during periods of activity.

The three psammophilous species *C. cribellus*, *C. laevinsculus* and *C. majorinus* are from sandy shores of Western Australia (Bartsch 1993). Delicate rosette pores uniformly cover the dorsal

plates of *C. cribellus*, and this ornamentation separates *C. cribellus* from *C. psammobius* and the other above mentioned species. The idiosomal length of *C. cribellus* is 217–232 μm. The length of *C. laevisculus* is 184–192 μm; its dorsal plates are almost smooth, the ds-1 stand adjacent to the gland pores, the OC are rather wide and the gland pore is near the middle of the plate, the margins in the posterior portion of the AE are almost parallel-sided, in both females and males the epimeral pores and genital acetabula are enlarged, and tibia I is not cylindrical as in *C. psammobius* but conspicuously widened near the segments middle. *Copidognathus majorinus* measures 218–224 μm; its plates are uniformly and delicately punctate, the OC are shorter than in *C. psammobius*, both females and males have enlarged epimeral pores and genital acetabula, the pgs on the male GA are arranged in two lines close to the lateral margin of the plate, and the tibiae bear articular lamellae.

Copidognathus pygmaeus Bartsch, 1980 is a species from a sandy shore of Massachusetts, United States Atlantic coast (Bartsch 1980). It is similar to the above mentioned species but the dorsal plates show delicately delimited areolae in which the plates are punctate and their surface bears foveae; and each OC bears one distinct and one weakly delimited cornea. *C. pygmaeus* reaches 217 μm in length.

Etymology. The name is derived from the Greek bios (to live), combined with psammos (sand), and refers to its lifestyle.

Distribution & Biology. *Copidognathus psammobius* is at present known from Moreton Bay, Queensland, Australia. The species was extracted from sediment of a slope, from the ground water table, and the adjacent flat, both habitats under strong freshwater influx, as well as from a beach without marked freshwater input.

Copidognathus cooki Bartsch, 2003

Copidognathus cooki Bartsch, 2003: 12–14, figs 1–17.

Material Examined. QM-S83661, ♀, ♂, Adam's Beach, Dunwich, North Stradbroke I., Moreton Bay (c. 27°30'S, 153°24'E), tidal flat immediately at the edge of the slope with *Juncus* and *Triglochin*, surface sediment, 17.02.2005, I. Bartsch. IBC, ♀, collection data as above. IBC, ♀, Adam's Beach, Dunwich, North Stradbroke I., Moreton Bay, mud flat with *Catenella* and *Bostrychia* (Rhodophyta). IBC, ♀, ♂, Myora Conservation Park, north of Dunwich, North Stradbroke I., Moreton Bay (c. 27°29'S, 153°24,5'E), from mudflat with *Calloglossa* (Rhodophyta) near a freshwater seepage, 22.02.2005, I. Bartsch.

Diagnosis. Length of female 264–281 μm, of male 269–294 μm. With three large spots of dark eye pigment. Dorsal plates reticulate-foveate. Slightly raised areolae with weakly developed rosette pores, each with wide fovea-like ostium and very delicate canaliculi; reticulate ornamentation of raised areolae similar to that of remaining areas. AD with three porose areolae, anterior areola extending into small frontal spine, posterior areolae elongate. PD with single pair of costae which are weakly developed and one rosette-pore wide, rarely two pores wide. OC posteriorly slender, elongate. Setae ds-2 in anteromedial margin of OC; ds-3 to ds-5 on PD. Ventral plates reticulate, each polygon with numerous delicate canaliculi. Opposing margins of AE and GA wide, truncate. Distance between anterior margin of female GA and GO equalling 1.3 times length of GO. Ovipositor extending slightly beyond GO. Male GA with 25–29 pgs. Spermatopositor large, extending beyond GO by almost length of GO. Rostrum not reaching end of P-2. Tectum triangular. Trochanters III and IV dorsally pointed. Telofemora short, from I–IV with 5, 5, 2, 2 setae. Tibiae I to IV ventrally with 2, 2, 1, 1 bipectinate setae, and 1, 1, 1, 1 slender and smooth setae. Tarsi III and IV with four and three setae. Claw pectines with distinct tines.

Remarks. Some of the mites had thecate suctorians attached; theca length 27–35 μm, stalk 25 μm.

Copidognathus cooki is classified a brackish water species which can survive fluctuations in salinity from brackish to fresh (Bartsch 2003). The type material was collected in the Swan River, Perth, Western Australia, at 2–6 ‰ salinity; in an area sometimes reached by upstream saltwater wedges of more than 24 ‰.

At the Adam's Beach and Myora Conservation Park collecting sites, *C. cooki* was present amongst the surface sediment of the tidal flat, adjacent to the shoreline freshwater seepage. During low tide the salinity in the muddy surface layer was reduced to 0–3‰. The species was also found on the mangrove mud flat at 18‰ (at low water), amongst *Calloglossa* sp., together with an *Aganopsis* species. At high tide, the salinity ranged from 28 to more than 30‰.

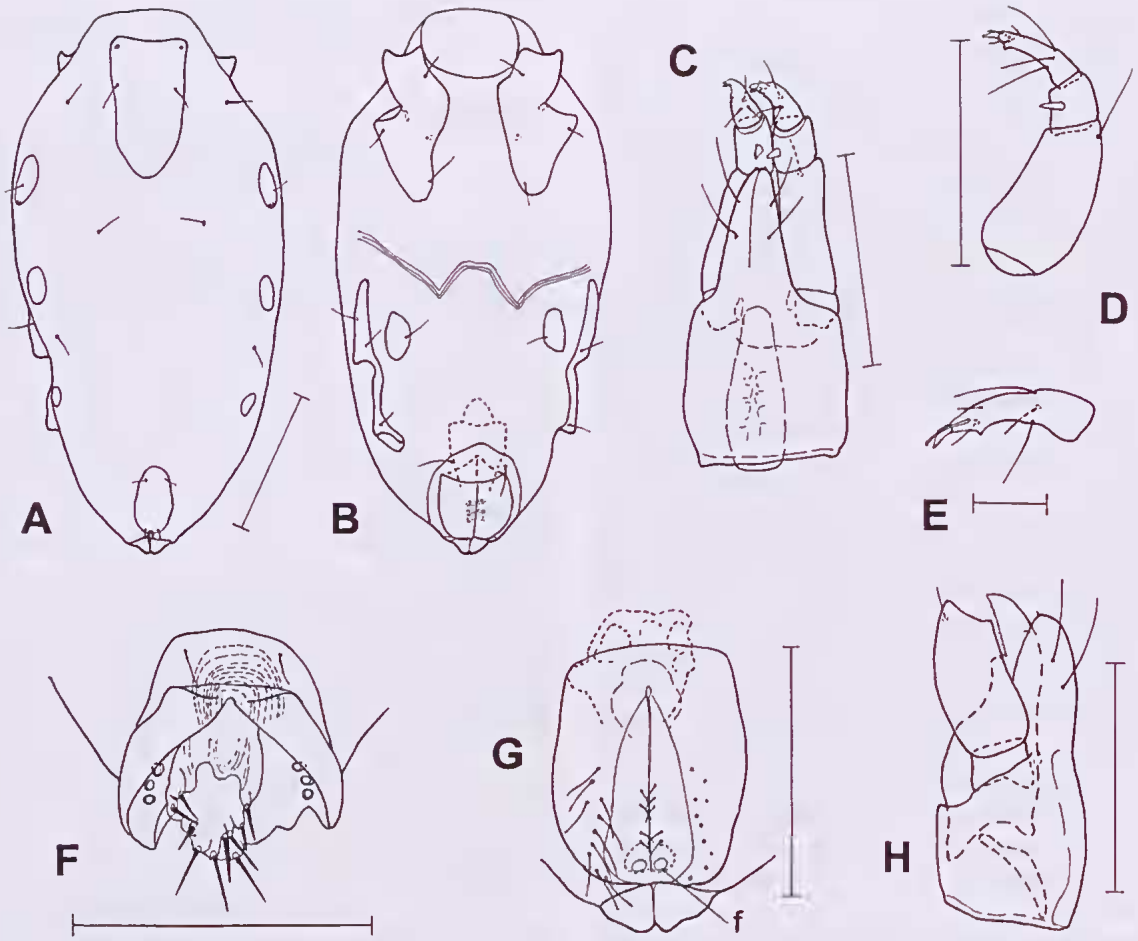

FIG. 4. *Halacaroides australiensis* sp. nov.; **A**, Idiosoma, dorsal, ♀; **B**, idiosoma, ventral, ♀; **C**, gnathosoma, ventral, ♀; **D**, P-2 to P-4, medial, ♀; **E**, P-4, lateral, ♀; **F**, genitoanal plate and ovipositor, ♀; **G**, genitoanal plate, ♂; **H**, gnathosoma, lateral, ♂. A–D, F–H, scale line = 50 μm, E, scale line = 10 μm. (f, fovea with genital acetabula) (A, B, D, E, holotype QM-S83662; C, paratype ZMH; F, paratype QM-S83663; G, paratype QM-S83664; H, paratype ZMH).

In samples taken during a previous Marine Biological Workshop in Esperance, Western Australia, *C. cooki* was regularly present in Bandy Creek, in shallow water substrata, amongst sand rich in organic material and *Polyphysa* (Chlorophyta) covered by debris (unpublished record). It was the only halacarid present in the samples. At the end of a dry summer the salinity in that creek amounted to 14–18‰ .

Distribution & Biology. Known from both south-eastern Australia, from Moreton Bay, Queensland, and south-western Australia from the Swan River, Perth, and Bandy Creek, Esperance, Western Australia. All records are from brackish water habitats, none from an exclusively marine shore.

Halacaroides Bartsch, 1981

Type species: *Halacaroides angustus* Bartsch, 1981.

Halacaroides australiensis sp. nov.
(Figs 4A–H, 5A–I)

Material Examined. QM-S83662, HOLOTYPE ♀, Adam's Beach, Dunwich, North Stradbroke I., Moreton Bay (c. 27°30'S, 153°24'E), upper slope, ground water table, 18.02.2005, I. Bartsch. PARATYPES. QM-S83663, ♀, collection data as above. QM-S83664,

♂, collection data as above. QM-S83665, deutonymph, collection data as above. SMF, ♂, collection data as above. ZMH, ♀, collection data as above. ZMH, ♂, collection data as above. IBC, ♀, ♂, collection data as above.

Diagnosis. Length of idiosoma 170–188 μm. Dorsal and ventral plates small, delicate. Anterior epimeral plate longitudinally divided. PE divided into marginal and small ventral portion. Marginal portion with three setae, ventral portion with one seta. Female with single pair of pgs; no sgs. Male GP with 10 pairs of pgs; genital sclerites with four to five pairs of sgs and posteriorly a pair of foveae. Gnathosoma slender, rostrum almost reaching to end of P-2. Palps with one seta on P-2, one medial spine on P-3, and three setae in basal whorl of P-4. Leg I much longer than leg II and longer than following legs. Leg chaetotaxy (pas excluded, solenidion and famulus included): leg I, 1, 2, 5, 5, 8, 8; leg II, 1, 2, 4, 5, 5, 4; leg III, 2, 2, 3, 3, 6, 4; leg IV, 1, 2, 3, 3, 5, 3. Tarsus III with lateral pas removed from tip of tarsus, tarsus IV with both pas removed.

Description. *Female.* Length of idiosoma 177–187 μm (from anterior margin of AD to end of anal cone), that of holotype 180 μm, width 95 μm. Dorsal plates delicate; integument between plates with parallel striae. Length of AD 48 μm, width 27 μm. Pair of gland pores near anterior margin of plate. Dorsum with three pairs of sclerites (Fig. 4A), 17, 15 and 9 μm in length, with delicate internal markings from muscle attachment. First pair of sclerites with delicate pore (pore canaliculus). PD much smaller than AD, its length 25 μm, width 12 μm. All dorsal idiosomal setae short. Pair of ds-1 in anterior half of AD. Pair of ds-2 in striated integument almost at the level of ds-1. One pair of setae laterally on anterior pair of sclerites, one pair dorsally in striated integument, and one pair of setae laterally between two posterior pairs of sclerites. PD with pair of dorsal setae and adanal setae.

AE longitudinally divided, length 38 μm, each half with three setae; no epimeral pores present (Fig. 4B). PE divided, length of marginal PE 62 μm. Marginal PE with one dorsal and two ventral setae, ventral PE with single seta. Length of GA 38 μm, width 29 μm. GO almost as large as genital plate; anterior part of GO covered by lamella. GA with single pair of pgs. Ovipositor in rest extending beyond GA. Three pairs of internal genital acetabula on inside of genital sclerites. Ovipositor with at least five pairs of slender genital spines (Fig. 4F).

Length of gnathosoma 70 μm, width 35 μm. Rostrum elongate, almost reaching end of P-2 (Fig. 4C, H). Tectum excavate. Both pairs of maxillary setae on rostrum, basal pair in about middle of rostrum. Tip of rostrum with two pairs of small rostral setae (Fig. 4H). Rostral sulcus extending backward beyond basal pair of maxillary setae. Palps four-segmented, P-2 with single dorsal seta, P-3 with stout, short medial spine (Fig. 4D). P-4 slightly curved, with three setae in a basal whorl; posterior half of P-4 with two setulae, one eupathid seta, a claw and a minute protuberance (Fig. 4E).

Legs slender, leg I much longer than leg II and longer than legs III and IV. Genu of leg I almost as long as telofemur but shorter than tibia I (Fig. 5A). Genua of legs II to IV shorter than telofemora. Tibia and telofemur II almost equal in length (Fig. 5B); tibiae III and IV longer than telofemora (Fig. 5C, D). Telofemur I 2.4 times longer than high, telofemora II to IV 2.0–2.1 times longer than high. Tarsus I with large lateral fossa membrane (Fig. 5E); medial membrane absent. The other tarsi with narrow medial and slightly wider lateral fossa membranes. Leg chaetotaxy (pas excluded; solenidion and famulus included): leg I, 1, 2, 5, 5, 8, 8; leg II, 1, 2, 4, 5, 5, 4; leg III, 2, 2, 3, 3, 6, 4; leg IV, 1, 2, 3, 3, 5, 3. All telofemora with a ventral seta. Genu I with pair of short ventral setae, genua II to IV with one ventral seta each. Tibia I with two pairs of slender ventral setae; tibiae II to IV with 2, 3, 2 ventral setae. These setae of tibiae II and IV long, stout and widened. Tarsi I to IV with 3, 0, 0, 0 ventral setae and each ending with pair of pas. Solenidion on tarsus I in dorsolateral position, 9 μm in length, famulus immediately adjacent, 8 μm long (Fig. 5E). Solenidion on tarsus II clavate, 7 μm long, inserted on narrow medial fossa membrane (Fig. 5F). Tarsus III with a short, eupathid dorsolateral seta (Fig. 5G). All tarsi with slender dorsal fossary seta, followed by paired, somewhat wider setae. Tarsi I and II with eupathid pas; on tarsus III medial pas eupathid, lateral pas long, slender, in more proximal position than medial pas; on tarsus IV both pas long, slender and in a proximal position, medial pas slightly closer to tip of tarsus than lateral pas.

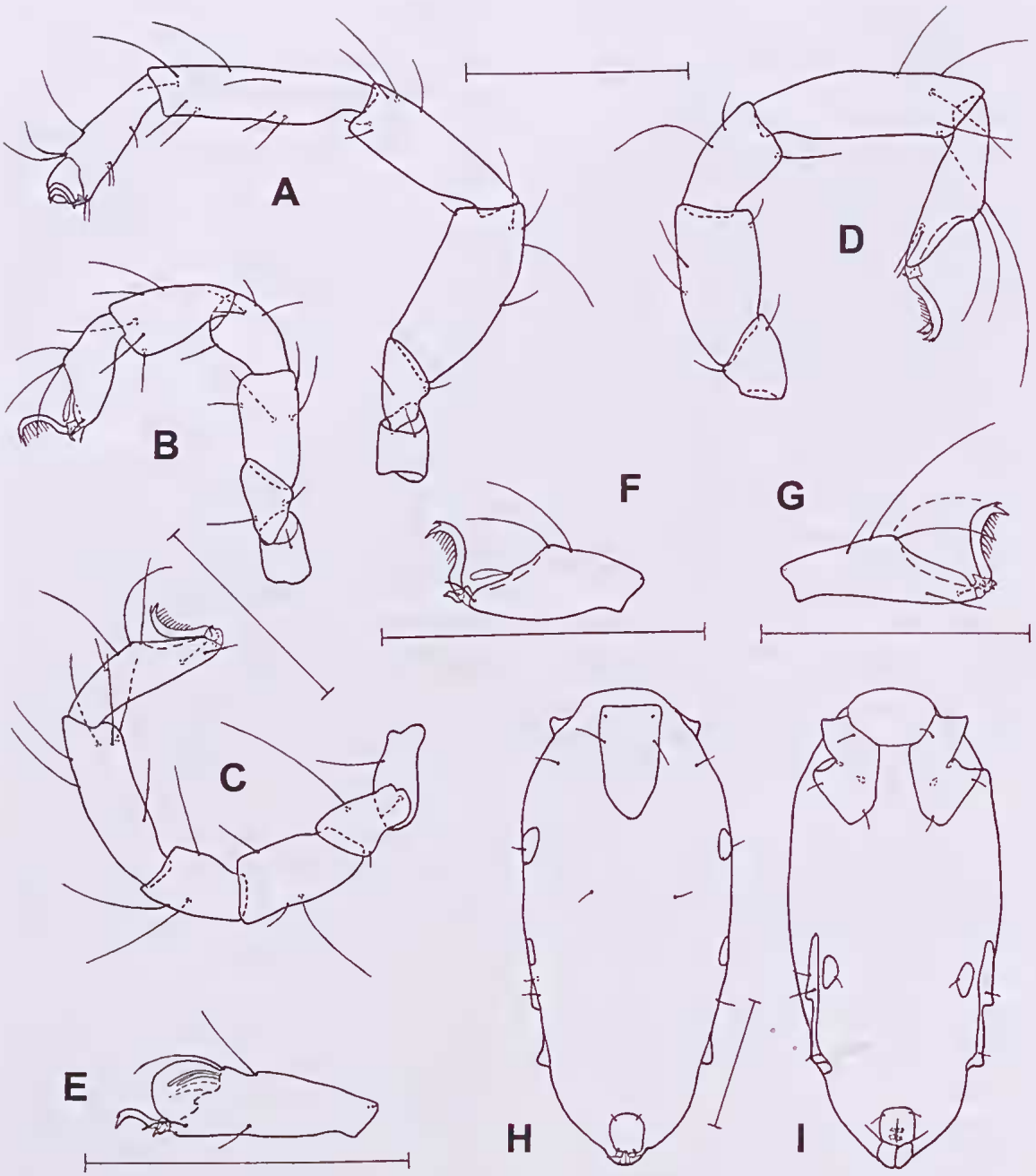

FIG 5. *Halacaroides australiensis* sp. nov.; **A**, Leg I, medial, ♂; **B**, leg II, medial, ♂; **C**, leg III, medial, ♂; **D**, basifemur to tarsus IV, medial, ♂; **E**, tarsus I, lateral, ♀ (medial setae and claw omitted); **F**, tarsus II, medial, ♂ (lateral setae and claw omitted); **G**, tarsus III, lateral, ♂ (medial setae in broken line); **H**, idiosoma, dorsal, deutonymph; **I**, idiosoma, ventral, deutonymph. Scale line = 50μm (A–D, F, G, paratype QM-S83664; E, paratype QM-S83663; H, I, paratype QM-S83665).

Claws on leg I smaller than on following legs. All claws with accessory process, those of tarsi II to IV with long, coarse tines. Median claw small, bidentate.

Male. Length of idiosoma 170–188 μm. Length of GA 82 μm, width 40 μm. Plate with ten pairs of pgs (Fig. 4G). Genital sclerites long and slender, indistinctly delimited from GA. Genital sclerites with four (and five) short sgs and posteriorly with pair of foveae, each including three genital acetabula and opening to exterior via 3 μm-wide pore. Spermatopositor extending beyond GA.

Deutonymh. Length 177 μm. Dorsal aspect (Fig. 5H) and outline of ventral plates AE and PE (Fig. 5I) similar to those of female. Number and arrangement of setae on dorsum, AE and PE same as in adults. Genital plate small, quadrangular, with pair of pgs and two pairs of internal genital acetabula. Leg chaetotaxy (pas excluded, solenidion and famulus included): leg I, 1, 2, 5, 5, 8, 8; leg II, 1, 2, 4, 5, 5, 4; leg III, 2, 2, 3, 3, 6, 4; leg IV, 1, 2, 2, 3, 5, 3. No ventral seta on telofemur IV.

Remarks. Two species were known to belong to *Halacaroides*, *H. angustus* Bartsch, 1981 and *H. brevocularis* Bartsch, 1981, both recorded from southern South America (Bartsch 1981). The present species differs in several characters, but these are not considered generically significant, and thus do not prevent the Australian species to be placed in *Halacaroides*.

The characters are:

1) The dorsum of *H. australiensis* bears seven instead of six pairs of idiosomal setae — the seta on the anterior pair of the lateral sclerites is expected to replace a gland pore. Setae associated with or replacing gland pores are known in species of the genera *Rhombognathides*, *Metarhombognathus* and *Lohmannella*.

2) The AE are not fused but longitudinally divided — in other genera, viz. *Anomalohalacarus* and *Metarhombognathus* (deutonymph), some species have a divided others a uniform AE. They are congeners despite the shape of their AE.

3) The females have a single pair of perigenital setae — three pairs of perigenital setae are present on the female GA of *H. angustus* and *H. brevocularis*, and this number is the most common state within halacarids, but both lower and higher numbers are documented, e.g. in *Rhombognathus*.

4) In *H. australiensis* males, the genital acetabula are moved to a posterior fovea — a similar situation is found in males of a few *Halacarellus* species which live in sand at at least periodically reduced salinity.

5) Trochanter III bears two setae — a re-examination of the type material of *H. angustus* showed that the telofemora III bear two setae, one in lateral and one in dorsal position. Furthermore, intrageneric differences in this character state occur, some *Halacarellus* species have one, others two setae on trochanter III.

6) *Halacaroides angustus* and *H. brevocularis* have a ventral seta on tarsus II, *H. australiensis* none — in several halacarid genera the number of ventral setae on tarsus II is known to vary.

Etymology. This is the first record from Australia, hence the name *australiensis*.

Distribution & Biology. Moreton Bay, Queensland. *Halacaroides australiensis* was only found in a beach strongly influenced by freshwater. Sediment from a small slope near the Moreton Bay Research Station, Dunwich, contained *Copidognathus psammobius* and *Anomalohalacarus* sp. but no *H. australiensis*.

Limnohalacarus Walter, 1917

Type species: *Halacarus wackeri* Walter, 1917.

Limnohalacarus billabongis Bartsch, 1999

Limnohalacarus billabongis Bartsch, 1999: 446–449, figs 3A–G, 4A–F, 5A–D.

Material Examined. QM-S83666, ♀, Adam's Beach, Dunwich, North Stradbroke I., Moreton Bay (c. 27°30'S, 153°24'E), tidal flat, subsurface sediment in 3–5 cm depth, 18.02.2005, I. Bartsch. IBC, 4 ♀♀, 1 deutonymph, collection data as above.

Diagnosis. Length of female 262–300 μm. Dorsal plates reticulate, ventral plates uniformly punctate. OC mostly undivided. All ventral plates fused. Area representing GA with 9–11 genital acetabula, one pair of pgs anterior to row of acetabula and two pairs close to GO; genital sclerites with two pairs of sgs. P-2 with one spur-like and one long, slender seta. Leg chaetotaxy (pas excluded, solenidion included): leg I, 1, 4, 4, 6, 8, 5; leg II, 1, 4, 4, 7, 4; leg III, 1, 2, 3, 4, 7, 4; leg IV, 0, 1, 3, 3, 6, 3. Tibia I with three ventral setae, two bristle-

like, one slender; tibia II with two ventral setae, one slightly barbed; tibia III with two pairs of ventral setae, two of them smooth, two bipectinate, tibia IV with single pair of smooth ventral setae. Solenidia setiform, all in dorsolateral position. Claws with distinct pectines. Tines on claw I long, on tarsi II to IV shorter, basal tines on small lamellar process.

Supplementary Description. In several adult specimens, OC partly divided by lateral wedge of striated integument extending transversely between triangular part around gland pore and larger anterior part of OC. One female unilaterally with single sgs on genital sclerite, another female unilaterally with four pgs.

Length of deutonymph 270 μm. OC completely divided by transverse fissure of striated integument.

Remarks. The present specimens differ from the type material in that the genital sclerites bear mostly two pairs of sgs (a single pair in the type specimens) and tibia I three ventral setae (four in the types).

Distribution & Biology. Queensland and Northern Territory, Australia. The first records were from Kakadu National Park, NT (Bartsch 1999). *Limnohalacarus billabongis* is primarily a freshwater mite.

Lobohalacarus Viets, 1939

Type species: *Walterella weberi* Romijn & Viets, 1924.

Lobohalacarus weberi (Romijn & Viets, 1924)

Walterella weberi Romijn & Viets, 1924: 217, figs 3–6.
Lobohalacarus weberi Viets, 1939: 506.

Material Examined. QM-S83667, ♀, deutonymph, Adam's Beach, Dunwich, North Stradbroke I., Moreton Bay (c. 27°30'S, 153°24'E), tidal flat, subsurface sediment in 3–5 cm, 18.02.2005, I. Bartsch. IBC, larva, Adam's Beach, edge of lower slope and tidal flat, surface sediment, 17.02.2005, I. Bartsch. IBC, 2 ♀♀, swamp area near Adam's Beach, freshwater pond, 18.02.2005, I. Bartsch, found together with the freshwater halacarids *Ropohalacarus uniscutatus* (Bartsch 1982) and *Soldanellonyx monardi* Walter, 1919.

Diagnosis. Length of female 350–360 μm, with frontal spine. Dorsal plates punctate and uniformly pitted. OC elongate. Dorsum with seven pairs of idiosomal setae. Ventral plates fused to a shield, area of PE with one dorsal, one lateral and one ventral seta; area of GA with five pairs of pgs. Genital sclerites with two to three pairs of genital acetabula. Gnathosoma slender. P-2 with one seta. P-3 with medial spine, P-4 with three setae in basal whorl. Leg I longer than leg II. Length of genu I similar to that of the leg's telofemur. Genu and tibia I ventrally with one spine, one bristle and two spines, two bristles, respectively. Tibiae II to IV ventrally with 2, 2, 1 bipectinate setae and 1, 1, 2 smooth bristles. Telofemora III and IV with 2/1 and 2/0 dorsal/ ventral setae, respectively. Tarsus I with large lateral fossa membrane. Solenidion on tarsus I in dorsolateral, on tarsus II in dorsomedial position. One of three ventral setae of tarsus I spur-like. Tarsi II to IV with 4/1, 4/1 and 3/1 dorsal/ ventral setae, respectively.

Supplementary Description. The female from the subsurface sediment of the tidal flat has three pairs of genital acetabula, while the two females from the freshwater pond have two pairs.

Idiosomal length of larva 154 μm. AD with frontal spine.

Remarks. *Lobohalacarus weberi* appears highly variable in characters such as the number and shape of setae on the legs and around the GO, and the number of genital acetabula on the genital sclerites. The present females are within the range of variation shown by European *L. weberi*. Data from Bartsch (1995) and from recent studies on freshwater halacarids of North America, from British Columbia to Newfoundland and California to Georgia (material forwarded by Dr. I. Smith, Ottawa; unpublished), showed that in most collections a range of character states exists, also unilateral combinations, though in a given population often one variant clearly dominates. The variants are thought to be intraspecific rather than representing several cryptic species.

Distribution & Biology. *Lobohalacarus* species are regularly found in the Australian groundwater (Harvey 1988; Proctor 2001; Boulton & Harvey 2003; Boulton *et al.* 2004). The first records of *L. weberi* were from Europe. When described subspecies are included, *L. weberi* must be considered a wide-spread species with records from Europe, North Africa, North America, Japan, Australia (present record), New Zealand, and

the Hawaiian and Tristan da Cunha Islands (Bartsch 1995, 2007).

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LITERATURE CITED

Angelier, E. 1954. Halacariens des sables littoraux méditerranées. *Vie et Milieu* **4**: 281–289.

Bartsch, I. 1977. Interstitielle Fauna von Galapagos. XX. Halacaridae (Acari). *Mikrofauna des Meeresbodens* **65**: 1–108.

1980. Halacaridae (Acari) im marinen Mesopsammal der Ostküste Nordamerikas. *Entomologische Mitteilungen aus dem Zoologischen Museum Hamburg* **6**: 393–405.

1982. Halacariden (Acari) im Süßwasser von Rhode Island, USA, mit einer Diskussion über Verbreitung und Abstammung der Halacaridae. *Gewässer und Abwässer* **68/69**: 41–58.

1981. Die Gattungen *Anomalohalacarus* und *Halacaroides* (Halacaridae, Acari), geographische Verbreitung, Bestimmungestabelle und Beschreibung dreier neuer Arten. *Zoologische Beiträge* **27**: 67–84.

1984. Three new psammobiont species of *Copidognathus* (Acari, Halacaridae) from the Philippines. *The Philippine Journal of Science* **113**: 201–214.

1988. Arenicolous Halacaridae (Acari) in Hawaiian waters. *Proceedings, Hawaiian Entomological Society* **28**: 213–228.

1991. Arenicolous Halacaridae (Acari) from Hong Kong. *Asian Marine Biology* 8: 57–75.

1993. Arenicolous Halacaridae (Acari) from southwestern Australia. Pp. 73–103. *In*, Wells, F.E., Walker, D.I., Kirkman, H. & Lethbridge, R. (Eds), *Proceedings of the Eleventh International Marine Biological Workshop: The Marine Flora and Fauna of Rottnest Island, Western Australia* (Western Australian Museum: Perth).

1995. A new subspecies of the freshwater halacarid mite *Lohohalacarus weberi* (Romijn & Viets) (Halacaridae, Acari) from a Southern Atlantic Ocean island. *Annals of the Cape Provincial Museums, Natural History* **19**: 171–180.

1996. Halacarids (Halacaroidea, Acari) in freshwater. Multiple invasions from the Paleozoic onwards? *Journal of Natural History* **30**: 67–99.

1999. Two new freshwater mites of the genus *Limnohalacarus* (Halacaridae: Acari) from Australia. *Records of the Western Australian Museum* **19**: 443–450.

2003. A new species of *Copidognathus* (Acari: Halacaridae: Copidognathinae) from Western Australia, with notes on Halacaridae in fresh and brackish water. Pp. 11–17. *In*, Smith, I. (Ed.), *An Acarological Tribute to David R. Cook (From Yankee Springs to Wheeny Creek)*. (Indira Publishing House: West Bloomfield, Michigan)

2004. Geographical and ecological distribution of marine halacarid genera and species (Acari: Halacaridae). *Experimental and Applied Acarology* **34**: 37–58.

2006a. Halacaroidea (Acari): a guide to marine genera. *Organisms Diversity & Evolution* **6**, Electronic Supplement 6: 1–104. (www.senckenberg.de/odes/ 06-06.htm)

2006b. 5. Acari: Halacaroidea. Pp. 113–157. *In*, Gerecke, R. (Ed.), *Süßwasserfauna von Mitteleuropa. 7/2-1 Chelicerata: Araneae, Acari I.* (Elsevier, Spektrum, Heidelberg)

2007. Freshwater Halacaridae (Acari) from New Zealand rivers and lakes, with notes on character variability. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut* **104**: 73–87.

Boulton, A. & Harvey, M. 2003. Effects of a spate on water mites in the hyporheic zone of an Australian subtropical river. Pp. 57–73. *In*, Smith, I. (Ed.), *An Acarological Tribute to David R. Cook (From Yankee Springs to Wheeny Creek)*. (Indira Publishing House: West Bloomfield, Michigan).

Boulton, A., Harvey, M. & Proctor, H. 2004. Of spates and species: responses by interstitial water mites to simulated spates in a subtropical Australian river. *Experimental and Applied Acarology* **34**: 149–169.

Harvey, M.S. 1988. A new species of *Lobohalacarus* from Australia (Chelicerata: Acarina: Halacaridae). *Memoirs of the Museum of Victoria* **49**: 363–365.

Otto, J.C. 2000. *Acarochelopodia* and *Actacarus* (Acari: Halacaridae) from northern Australia, with remarks on *A. pacificus* and *A. orthotectus*. *Species Diversity* **5**: 111–127.

Proctor, H.C. 2001. Extracting aquatic mites from stream substrates: a comparison of three methods. *Experimental and Applied Acarology* **25**: 1–11.

Romijn, G. & Viets, K. 1924. Neue Milben. *Archiv für Naturgeschichte* **90**: 215–225.

Trouessart, E. 1888. Note sur les acariens marins recueillis par M. Giard au laboratoire maritime de

Wimereux. *Comptes rendus de l'Académie des Sciences, Paris* **107**: 753–755.

Viets, K. 1939. Über die Milbengruppe der Porohalacaridae (Acari). Zugleich ein Beitrag zur Kenntnis der Milbenfauna der Bremer Umgebung und des Plöner Sees. *Abhandlungen. Naturwissenschaftlicher Verein zu Bremen* **31**: 502–514.

Walter, C. 1917. Schweizerische Süßwasserformen der Halacariden. *Revue de Suisse Zoologie* **25**: 411–423.

1919. Schweizerische Süßwasserformen der Halacariden. II. *Revue de Suisse Zoologie* **27**: 235–242.